

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Letters Patent of:
Keith R. Reynolds et al.

Patent No.: 7,197,661

Issued: March 27, 2007

For: SYSTEM AND METHOD FOR DYNAMIC
MIRRORING OF A NETWORK
CONNECTION

**REQUEST FOR CERTIFICATE OF CORRECTION
PURSUANT TO 37 CFR 1.322**

Attention: Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Upon reviewing the above-identified patent, Patentee noted typographical errors which should be corrected. A listing of the errors to be corrected is attached.

The typographical errors marked with a "P" on the attached list are not in the application as filed by applicant. Also given on the attached list are the documents from the file history of the subject patent where the correct data can be found.

The errors now sought to be corrected are inadvertent typographical errors the correction of which does not involve new matter or require reexamination.

Transmitted herewith is a proposed Certificate of Correction effecting such corrections. Patentee respectfully solicits the granting of the requested Certificate of Correction.


Patent No.: 7,197,661

Docket No.: 08204/0200314-US0

The Commissioner is authorized to charge any deficiency of up to \$300.00 or credit any excess in this fee to Deposit Account No. 04-0100.

Dated: May 31, 2007

Respectfully submitted,

By  _____

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UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

PATENT NO. : 7,197,661

Page 1 of 1

APPLICATION NO.: 10/729,720

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INVENTOR(S) : Reynolds et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the face page, in field (56), under "Other Publications", in column 1, line 2, delete "Dicionary" and insert - - Dictionary - -, therefor.

In column 7, line 38, delete "10." and insert - - 110. - -, therefor.

In column 16, line 27, in Claim 30, delete "resource" and insert - - resource, - -, therefor.

MAILING ADDRESS OF SENDER (Please do not use customer number below):

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Issued Patent Proofing Form
Note: P = **PTO Error**

A = **Applicant Error**

File#: **08204/0200314-US0**

US Serial No.: **10/729,720**

US Patent No.: **US 7,197,661 B1**

Issue Dt.: **Mar. 27, 2007**

Title: **SYSTEM AND METHOD FOR DYNAMIC MIRRORING OF A NETWORK CONNECTION**

Sr. No.	P/A	Original		Issued Patent		Description Of Error
		Page	Line	Column	Line	
1	P	Page 1 of 1 List of references cited by examiner (06/16/2006)	Entry 1 Line 1 (Non-Patent Documents)	First Page Col. 1 (Other Publications)	2	Delete "Dicitony" and insert - - Dictionary - -, therefor.
2	P	Page 11 Specification (12/05/2003)	21	7	38	Delete "10." and insert - - 110. - -, therefor.
3	P	Page 8 Claims (09/14/2006)	2	16	27 (Approx.)	In Claim 30, delete "resource" and insert - - resource, - -, therefor.



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(54) **SYSTEM AND METHOD FOR DYNAMIC
MIRRORING OF A NETWORK
CONNECTION**

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 496 days.

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G06F 11/00 (2006.01)

(52) **U.S. Cl.** **714/4**

(58) **Field of Classification Search** **714/4**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,187,706 A * 2/1993 Frankel et al. 370/217
2002/0176355 A1 11/2002 Mimms
2004/0003094 A1 * 1/2004 See 709/227

OTHER PUBLICATIONS

"Compress" "Decompress" "SSL" "Proxy" Microsoft Computer
Dictionary (fifth edition). Copyright 2002. Microsoft Press.*

Null, Linda: "The Essentials of Computer Organization and Archi-
tecture." Copyright 2003. Jones and Bartlett Computer Science. pp.
521-524, 538-546.*

BIG-IP Reference Guide, Version 4.5, Chapter 13 Configuring a
Redundant System, pp. 13-1-13-20.

* cited by examiner

Primary Examiner—**Robert W Beausoliel, Jr.**

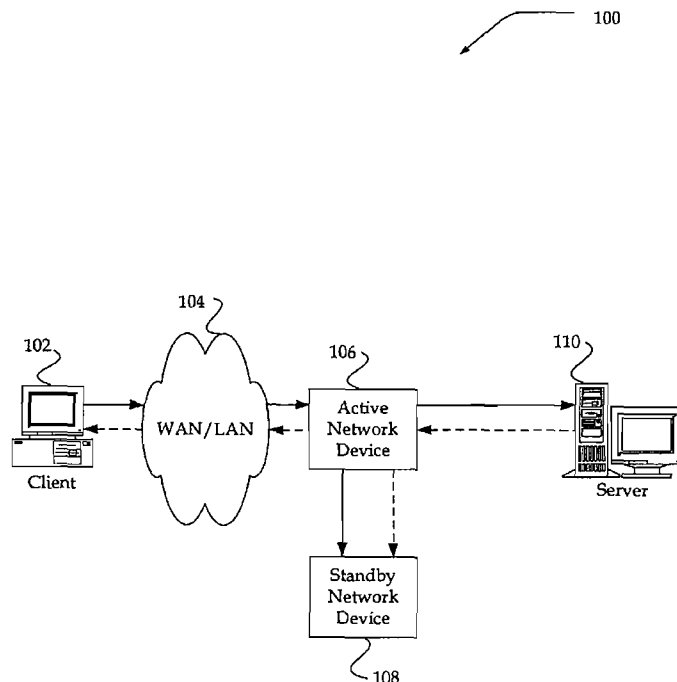
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(57) **ABSTRACT**

Methods and systems are directed to dynamically mirroring
a connection between network devices. Mirroring is man-
aged by forwarding a packet between a first network device
and a second network device. In one method, the first
network device receives the packet from a client and com-
municates the packet to the second network device. A
forwarding device, pre-determined from the first and second
network devices, forwards the packet to a server. The first
network device receives a response from the server, and
communicates it to the second network device. The forward-
ing device forwards the response packet to the client. In one
configuration, the first network device and forwarding
device is an active device, and the second network device is
a standby device. In another configuration, the first network
device is a standby device, and the second network device
and forwarding device is an active device.

45 Claims, 8 Drawing Sheets



Standby network device 108 is configured to perform substantially the same operations on the mirrored packet as active network device 106 might perform. However, standby network device 108 is configured typically not to send out its output, unless it becomes the active network device. During a complex operation, such as SSL, standby network device 108 is configured to receive and employ certain information from active network device 106. Such information may include a random seed, a server-random, encryption keys, certificates, and the like. Standby network device 108 may also receive and employ certain information from active network device 106 during other situations. This additional information may include an initial sequence number, and the like.

Communicating virtually the same packets to standby network device 108 enables standby network device 108 to construct virtually an equivalent internal state, substantially similar to one maintained by active network device 106. This enables a more rapid failover response should active network device 106 fail than might occur should standby network device 108 have to regenerate the actions from static information about the connections. This also enables complex, high-level protocols, such as compression, SSL, and the like, to be mirrored with minimal additional state information transferred from active network device 106. In some instances, such as with a compression action, virtually no transfer of state information may be needed.

FIG. 2 illustrates one embodiment of an environment in which a system operates for managing reliability of a mirrored connection using a standby response configuration. Not all the components may be required to practice the invention, and variations in the arrangement and type of the components may be made without departing from the spirit or scope of the invention.

As shown in the figure, system 200 includes client 102, wide area network (WAN)/local area network (LAN) 104, active network device 206, standby network device 208, and server computer 110. Components numbered similar to those in FIG. 1 operate substantially similar. Active network device 206 is configured to perform similar to active network device 106 in FIG. 1. Similarly, standby network device 208 is configured to perform similar to standby network device 108 in FIG. 1. A difference between the environment shown in FIG. 1 and that shown in FIG. 2 is that the WAN/LAN 104 is in communication with client 102, active network device 206, and standby network device 208. Active network device 206 is also in communication with standby network device 208 and with server computer 110. Standby network device 208 is further in communication with server 110.

The flow of packets shown in FIG. 2 is described in more detail below in conjunction with FIG. 6. Briefly, however, as shown in FIG. 2, standby network device 208 is configured to send substantially all mirrored packets, including acknowledgement packets as appropriate, forwarded connection data, and the like, that might typically be sent by active network device 106 as shown in FIG. 1. Moreover, should a packet be dropped, corrupted, and the like, while being transferred between active network device 206 and standby network device 208, the appropriate network peer is configured to retransmit the packet, data, and the like, virtually the same as if it had been dropped at any other point in the network.

FIG. 3 illustrates one embodiment of an environment in which a system operates for managing reliability of a mirrored connection using a standby first configuration. Not all the components may be required to practice the inven-

tion, and variations in the arrangement and type of the components may be made without departing from the spirit or scope of the invention.

As shown in the figure, system 300 includes client 102, wide area network (WAN)/local area network (LAN) 104, active network device 306, standby network device 308, and server computer 110. Components numbered similar to those in FIG. 1 can operate in substantially similar ways. Active network device 306 is configured to perform similar to active network device 106 in FIG. 1. Similarly, standby network device 308 is configured to perform similar to standby network device 108 in FIG. 1. A difference between the environment shown in FIG. 1 and that shown in FIG. 3 is that the WAN/LAN 104 is in communication with client 102, active network device 306, and standby network device 308. Active network device 306 is also in communication with standby network device 308 and with server computer 110. Standby network device 308 is further in communication with server 110.

The flow of packets shown in FIG. 3 is described in more detail below in conjunction with FIG. 7. Briefly, however, as shown in FIG. 3, reliability of mirrored connections is ensured by arranging packets to be sent to standby network device 308 first. Standby network device 308 is configured to forward the packets to active network device 306. Active network device 306 forwards the packets as with non-mirrored connections.

FIG. 4 illustrates a functional block diagram of one embodiment of a network device in which the invention may be practiced. It will be appreciated that not all components of network device 400 are illustrated, and that network device 400 may include more or fewer components than those shown in FIG. 4. Network device 400 may operate, for example, as a router, bridge, firewall, gateway, traffic management device, distributor, load balancer, server array controller, or proxy server. The communications may take place over a network, such as network 104 in FIGS. 1-3, the Internet, a WAN, LAN, or some other communications network known to those skilled in the art.

As illustrated in FIG. 4, network device 400 includes a central processing unit (CPU) 402, mass memory, and a network interface unit 412 connected via a bus 404. Network interface unit 412 includes the necessary circuitry for connecting network device 400 to network 104, and the like, and is constructed for use with various communication protocols including the TCP/IP and UDP/IP protocol. Network interface unit 412 may include or interface with circuitry and components for transmitting messages and data over a wired and/or wireless communications medium. Network interface unit 412 is sometimes referred to as a transceiver.

The mass memory generally includes random access memory ("RAM") 406, read-only memory ("ROM") 414, and one or more permanent mass storage devices, such as hard disk drive 408. The mass memory stores operating system 416 for controlling the operation of network device 400. The operating system 416 may comprise an operating system such as UNIX, LINUX™, Windows™, and the like.

In one embodiment, the mass memory stores program code and data for implementing a connection mirroring 418, and related program code and data, in accordance with the present invention. The mass memory may also store additional programs 424 and data for performing the functions of network device 400. Programs 424 may also include applications that are employed by connection mirroring 418 to handle complex, high-level protocols, including, but not limited to, compression and Secure Socket Layer (SSL) operations on packets.

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forwarding the copy of the packet to another network device, wherein the copy of the packet is forwarded exclusively by the standby network device;
 receiving, exclusively by the active network device, a response packet from the other network device;
 communicating a copy of the response packet to the standby network device; and
 forwarding, exclusively by the standby network device, the copy of the response packet towards the resource.

20. The method of claim 19, further comprising:
 synchronizing the standby network device with the active network device by communicating pre-determined information about each active connection to the standby network device on a busiest connection first order of connections.

21. The method of claim 20, wherein the pre-determined information includes at least one of a change in a sequence number, and a Network Address Translation (NAT), and a port address translation.

22. A method for mirroring a connection in a network, comprising:
 receiving, exclusively by a standby network device, a packet from a resource;
 forwarding a copy of the packet to an active network device;
 forwarding a copy of the packet to another network device, wherein the copy of the packet is forwarded by the active network device;
 receiving, by the standby network device, a response packet from the other network device;
 forwarding a copy of the packet to the active network device; and
 forwarding, exclusively by the active network device, the copy of the response packet towards the resource.

23. The method of claim 22, wherein forwarding the copy of the packet to the other network device further comprises transforming the copy of the packet, and wherein forwarding the copy of the response packet further comprises transforming the copy of the response packet.

24. The method of claim 23, wherein transforming the packet further comprises sharing information associated with the transformation between the active network device and the standby network device.

25. A network device, for mirroring a connection with another network device in a network, comprising:
 a transceiver arranged to receive and forward a packet;
 a processor, coupled to the transceiver, that is configured to perform actions, including:
 receiving a packet from a resource, wherein the packet is sent exclusively towards the network device by the resource;
 communicating the packet to the other network device;
 if the network device is a forwarding device, exclusively forwarding the packet towards a server;
 receiving a response packet from the server;
 communicating the response packet to the other network device; and
 if the network device is the forwarding device, exclusively forwarding the response packet towards the resource.

26. The network device of claim 25, further comprising:
 if the other network device is the forwarding device, enabling the other network device to forward the packet towards the server, and to forward the response packet towards the resource.

27. The network device of claim 25, wherein the network device and the other network device are configured to

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operate as at least one of a load-balancer, a router, a firewall, a proxy, a bridge and a network address translation device.

28. A standby network device, for mirroring a connection with an active network device in a network, comprising:
 a transceiver arranged to receive and forward a packet;
 a processor, coupled to the transceiver, that is configured to perform actions, including:
 receiving a packet exclusively from a resource;
 communicating a copy of the packet to the active network device;
 receiving a response packet from another resource, wherein the response packet is in response to the other resource receiving a copy of the packet exclusively from the active server; and
 communicating a copy of the response packet to the active network device.

29. The standby network device of claim 28, wherein the active device is configured to communicate an acknowledgement packet to the resource in response to receiving the copy of the packet, and to further communicate another acknowledgement packet to the other resource in response to receiving the copy of the response packet.

30. A system for mirroring a connection in a network, comprising:
 (a) a first network device, configured to perform actions, including:
 receiving a packet from a resource wherein the packet is sent exclusively towards the first network device by the resource;
 sending the packet to a second network device;
 if the first network device is a pre-determined forwarding network device, forwarding the packet towards another resource, wherein the packet is sent towards the other resource exclusively by the first network device;
 receiving a response packet from the other resource; and
 if the first network device is the pre-determined forwarding network device, forwarding the response packet towards the resource, wherein the response packet is sent towards the resource exclusively by the first network device; and
 (b) the second network device, coupled to the first network device, and configured to perform actions, including:
 receiving the packet from the first network device; and
 if the second network device is the pre-determined forwarding network device, forwarding the packet towards the other resource, and forwarding the response packet towards the resource, wherein the packet is sent towards the other resource exclusively by the second network device, and the response is sent towards the resource exclusively by the second network device.

31. The system of claim 30, wherein the first network device is an active network device, the second network device is a standby network device, and the forwarding network device is the active network device.

32. The system of claim 30, wherein the first network device is an active network device, the second network device is a standby network device, and the forwarding device is the standby network device.

33. The system of claim 30, wherein the first network device is a standby network device, the second network device is an active network device, and the forwarding device is the active network device.